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AUTHOR Gourgey, Annette F.
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ABSTRACT

Evidence suggests that victims of mathematics anxiety suffer from a poor self-concept regarding their mathematical ability. A 27-item attitude scale was developed reflecting attitude toward one's ability to learn mathematics. This scale was administered to 92 students taking a required statistics course, along with the Mathematics Anxiety Rating Scale, an arithmetic test, a list of erroneous statements about mathematics, and a midterm examination. Mathematical self-concept was moderately related to mathematics anxiety and was more highly correlated with arithmetic skills, acceptance of erroneous beliefs about mathematics, performance on the midterm examination, and number of years since last mathematics course than was mathematics anxiety. It was suggested that mathematical self-concept is an important dimension of attitude in mathematics learning to consider in both research and remediation. (Author)

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Development of a Scale for the Measurement of Self-Concept in Mathematics

Annette F. Gourgey

New York University

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Abstract

Evidence suggests that victims of mathematics anxiety suffer from a poor self-concept regarding their mathematical ability. A 27-item attitude scale was developed reflecting attitude toward one's ability to learn mathematics. This scale was administered to 92 students taking a required statistics course, along with the Mathematics Anxiety Rating Scale, an arithmetic test, a list of erroneous statements about mathematics, and a midterm examination. Mathematical self-concept was moderately related to mathematics anxiety and was more highly correlated with arithmetic skills, acceptance of erroneous beliefs about mathematics, performance on the midterm examination, and number of years since last mathematics course than was mathematics anxiety. It was suggested that mathematical self-concept is an important dimension of attitude in mathematics learning to consider in both research and remediation.

Development of a Scale for the Measurement of Self-Concept in Mathematics

Knowledge of mathematics is now recognized as vital for entry into many careers. Along with the increased recognition of the need for mathematical competence has come an increased recognition of mathematics anxiety as a widespread impediment to mathematical performance in both academic settings and everyday life. Research on the nature and correlates of affect toward mathematics has shown that people frequently experience strong feelings of fear and anxiety toward mathematics, and that these feelings are associated with avoidance and poor performance in mathematics (Aiken, 1970, 1976; Betz, 1978; Kogelman & Warren, 1979; Poffenberger & Norton, 1959; Richardson & Suinn, 1972; Tobias, 1978).

Studies of attitude toward mathematics have demonstrated that feelings of liking and fear of mathematics are related to achievement for both children and adults (Aiken, 1963, 1972, 1974; Aiken & Dreger, 1961; Dreger & Aiken, 1957; Dutton, 1956; Feinberg & Halperin, 1978). Moreover, it has frequently been observed that mathematically anxious people make disparaging remarks not only about the subject of mathematics but about their own ability to perform in mathematics (Donady & Tobias, 1977; Kogelman, Nigro, & Warren, 1978; Kogelman & Warren, 1979; Tobias, 1978).

Though researchers have demonstrated that self-concept of ability affects children's academic performance in a variety of areas, including arithmetic (Brookover, Paterson, & Thomas, 1962), and specialists in the treatment of mathematics anxiety have pointed out the frequency of low self-esteem and feelings of incompetence among victims of mathematics anxiety (Kogelman et al., 1978), little research has been done on the nature and measurement of mathematical self-concept and its relationship to performance.

The purpose of this study was to develop a valid and reliable measure of mathematical self-concept and to clarify its relationship to mathematics anxiety and to performance in mathematics. The construct of mathematical self-concept was developed during three years of tutoring undergraduate and graduate students taking a required basic statistics course, at which time I noted that students having difficulties with the course frequently made disparaging remarks regarding their ability to learn mathematics, despite academic accomplishment in other areas of study. Thus, mathematical self-concept is defined as beliefs, feelings or attitudes regarding one's ability to understand or perform in situations involving mathematics. The self as capable or incapable of learning or performing in mathematics, rather than the subject of mathematics, is the object of attitude.

Method

Subjects

Two groups of subjects, a total of 120 people, participated in this study. The pilot sample consisted of 28 undergraduate and graduate students enrolled in a required basic statistics course given in the School of Education, Health, Nursing and Arts Professions at New York University. The main sample consisted of 92 undergraduate and graduate students, 16 male and 76 female, enrolled in the same basic statistics course the following semester. Students in the main sample ranged in age from 18 to 57 years, with a mean age of 27, and were enrolled in a variety of undergraduate and graduate programs, mostly in the health professions.

Development of the Scale

Based on written statements from undergraduate students taking a basic mathematics course at New York University, 32 scale items were derived which reflected attitude toward one's mathematical ability. Items were worded both positively and negatively. Respondents were asked to indicate degree of agreement or disagreement with each item on the following scale: Agree Strongly (5), Agree Somewhat (4), Undecided (3), Disagree Somewhat (2), Disagree Strongly (1). Scoring on negatively worded items was reversed so that a high score would indicate a favorable mathematical self-concept.

The Mathematical Self-Concept Scale was submitted to three mathematicians experienced in the remediation of mathematics anxiety and basic mathematical skills, in order to establish content validity. Modifications of a few items were recommended. The scale was then given to the sample of 28 students. Two items which elicited confusion among respondents were reworded, and a few redundant items (having a correlation above .9 with other items) were eliminated, for a final total of 27 items (see Table 1). Items 2, 4, 7, 10, 12, 13, 18, 20, 24, 26 and 27 are worded in a positive direction; the remaining items are worded in a negative direction. Possible scores range from a low of 27 to a high of 135.

Insert Table 1 about here

Procedure

The main sample of 92 students was given the final version of the Mathematical Self-Concept Scale at the end of the first class session of the semester. In addition to the Mathematical Self-Concept Scale, students were given the Mathematics Anxiety Rating Scale, or MARS (Richardson & Suinn, 1972), and a test of arithmetic skills (Durost, Bixler, Wrightstone, Prescott, & Balow, 1970), and were asked to indicate agreement or disagreement with a list of

erroneous statements about mathematics (Gourgey, 1982). Examples of erroneous statements included: The most important thing in doing math is to use the right formulas; Some people have a mathematical mind and some don't; Math requires only logic, not intuition. After eight weeks, students took a midterm examination covering topics in descriptive statistics.

Results

The mean mathematical self-concept on the final form of the scale for the sample of 92 students was 94.53, the standard deviation was 21.88, and the actual range of scores was from 34 to 133. Due to the small number of males in the sample, sex differences could not be evaluated.

The internal consistency reliability (by coefficient alpha) of the preliminary version of the scale, using the sample of 28 students, was .98. After revisions, the reliability of the final version of the scale was .96 (N = 92). All item-total correlations but one in the final version were above .5. In addition, a principal components factor analysis was performed on the scale items which showed most of the variance among items to be accounted for by one factor.

The correlation of the preliminary version of the Mathematical Self-Concept Scale with self-report of anxiety about mathematics was -.71; this result was

statistically significant, t (26) = -5.14, $p < .001$. The correlation matrix for the five tests given to the main sample is presented in Table 2. It can be seen that mathematical self-concept correlates moderately highly with mathematics anxiety as measured by the MARS; this result was statistically significant, $r = -.62$, t (90) = -7.50, $p < .001$. However, mathematical self-concept correlates more highly with acceptance of erroneous beliefs about mathematics, arithmetic skills, and performance on the midterm examination than does mathematics anxiety. (Due to the relative simplicity of the material covered by the midterm examination, the distribution of midterm exam scores was highly negatively skewed and had a relatively small variance. This may have accounted for its low correlations with the other variables.)

Insert Table 2 about here

Additional analyses were performed regaring age of student and number of years since last mathematics course, both previously found to correlate with mathematics anxiety (Betz, 1978), and their relationship to mathematical self-concept and mathematics anxiety. These results are presented in Table 3. (A few students did not supply demographic information and had to be omitted from these analyses.) Not surprisingly, the correlation of age with

number of years since last mathematics course was moderately high; yet these two variables were not equally related to the affective variables. Age was only slightly more related to mathematical self-concept than to mathematics anxiety. However, number of years since last mathematics course was more strongly related to mathematical self-concept than to mathematics anxiety.

Insert Table 3 about here

Discussion

Research on affect toward mathematics has suggested that both children and adults may experience not only mathematics anxiety which interferes with their performance in mathematics courses, but an impaired self-concept in mathematics as well. In order to measure self-concept in mathematics, a 27-item Likert-type attitude scale was developed and validated on a sample of undergraduate and graduate students taking a required basic statistics course.

The results of the analyses of the Mathematical Self-Concept Scale provide support for its validity and reliability as a measure of mathematical self-concept. Both the item-total correlations and the internal consistency reliability were high; additionally, a principal components factor analysis showed most of the variance of the scale items to be accounted for by one factor. These results

suggest that the Mathematical Self-Concept Scale measures one construct.

The moderately high correlation of the Mathematical Self-Concept Scale with measures of mathematics anxiety also lends support to the validity of the scale as a measure of mathematical self-concept. It is interesting to note that the correlation of the Mathematical Self-Concept Scale with the MARS was identical to the correlation between mathematics anxiety and mathematics confidence obtained by Sudweeks, Stoler, and Croker (1980) using completely different measures for both variables. This lends further support to the construct of mathematical self-concept and its relationship to mathematics anxiety.

The fact that mathematical self-concept correlated more highly than did mathematics anxiety with many of the variables used in this study suggests that mathematical self-concept may be a more powerful and more informative variable than mathematics anxiety: not only does it relate more strongly to other variables involved in learning mathematics, it also supplies more specific information about the nature of the mathematics learner's difficulty. Since mathematics anxiety is currently receiving a great deal of attention as a correlate of mathematics performance and many mathematics anxiety treatment programs have been established to deal with this problem, the results of this study suggest mathematical self-concept as a dimension of

attitude in mathematics learning which has received little attention but which may be valuable to consider in both research and treatment of mathematics anxiety.

References

Aiken, L. R., Jr. Affective factors in mathematics learning: Comments on a paper by Neale and a plan for research. Journal for Research in Mathematics Education, 1970, 1, 251-255.

Aiken, L. R., Jr. Personality correlates of attitudes toward mathematics. Journal of Educational Research, 1963, 56, 476-480.

Aiken, L. R., Jr. Research on attitudes toward mathematics. Arithmetic Teacher, 1972, 19, 229-234.

Aiken, L. R., Jr. Two scales of attitude toward mathematics. Journal for Research in Mathematics Education, 1974, 5, 67-71.

Aiken, L. R., Jr. Update on attitudes and other affective variables in learning mathematics. Review of Educational Research, 1976, 46, 293-311.

Aiken, L. R., Jr., & Dreger, R. M. The effect of attitudes on performance in mathematics. Journal of Educational Psychology, 1961, 52, 19-24.

Betz, N. E. Prevalence, distribution, and correlates of math anxiety in college students. Journal of Counseling Psychology, 1978, 25, 441-448.

Brookover, W. B., Paterson, A., & Thomas, S. Self-concept of ability and school achievement: The relationship of self-images to achievement in junior high school subjects. U.S. Department of Health, Education and Welfare Cooperative Research Project No. 845, December, 1962. (ERIC Document Reproduction Service No. ED 02 946)

Donady, B., & Tobias, S. Math anxiety. Teacher, 1977, 95(3), 71-74.

Dreger, R. M., & Aiken, L. R., Jr. The identification of number anxiety in a college population. Journal of Educational Psychology, 1957, 48, 344-351.

Durost, W. N., Bixler, H. H., Wrightstone, J. W., Prescott, G. A., & Balow, I. H. Metropolitan achievement test: Advanced (grades 7.0-9.5), form F (4th ed.), Test 3: Mathematics computation. New York: Harcourt, Brace, Jovanovich, 1970.

Dutton, W. H. Attitudes of junior high school pupils toward arithmetic. School Review, 1956, 64, 18-22.

Feinberg, L. B., & Halperin, S. Affective and cognitive correlates of course performance in introductory statistics. Journal of Experimental Education, 1978, 46(4), 11-18.

Gourgey, A. F. The relationship of beliefs about mathematics, mathematical self-concept and arithmetic skills to mathematics anxiety and performance in basic statistics. Unpublished doctoral dissertation, New York University, 1982.

Kogelman, S., Nigro, E., & Warren, J. Mind over math: Overcoming math anxiety at the Dalton School. Independent School, 1978, 37(4), 44-46.

Kogelman, S., & Warren, J. Mind over math. New York: McGraw-Hill, 1979.

Poffenberger, T., & Norton, D. Factors in the formation of attitudes toward mathematics. Journal of Educational Research, 1959, 52, 171-176.

Richardson, F. C., & Suinn, R. M. The Mathematics Anxiety Rating Scale: Psychometric data. Journal of Counseling Psychology, 1972, 19, 551-554.

Sudweeks, R. R., Stoler, S., & Croker, M. Development of the Syracuse Mathematics Anxiety Scale. Paper presented at the annual meeting of the American Educational Research Association, April, 1980. (ERIC Document Reproduction Service No. ED 186 266)

Tobias, S. Overcoming math anxiety. New York: W. W. Norton, 1978.

Table 1

Items on the Mathematical Self-Concept Scale

1. It takes me much longer to understand mathematical concepts than the average person.
2. I have never felt myself incapable of learning math.
3. I have a mental block when it comes to math.
4. I have a good mind for math.
5. If I can understand a math problem, then it must be an easy one.
6. It has always seemed as if math required brain cells I didn't have.
7. I can understand math better than most people.
8. Whenever I am exposed to math, I feel that it is beyond me.
9. I don't ask questions in math classes because mine sound so stupid.
10. I have no more trouble understanding math than any other subject.
11. I just don't have a mathematical mind.
12. When I have difficulties with math, I know I can handle them if I try.
13. My mathematical ability is above average.
14. I have never been able to think mathematically.
15. I always feel like a dummy in my math classes.
16. I don't have a good enough memory to learn math.
17. I get very tense when I see a math problem because I know I will not be able to do it.
18. I never feel like a mathematical incompetent.
19. Whenever I do a math problem, I am sure that I have made a mistake.
20. I feel secure in my ability to do math.

Table 1 (continued)

21.	If my eating depended on my ability to do math, I would undoubtedly starve to death.
22.	I have no facility with numbers.
23.	Whenever I have to take math, I worry about whether I can pass.
24.	When I have to do math problems, I do not worry about whether I will be able to do them.
25.	Whenever I do math problems, I end by giving up in despair.
26.	I never worry about failing math.
27.	When I do math, I feel confident that I have done it correctly.

Table 2

Correlation Matrix for the Five Tests Given to Participants[a]

	MSC	MA	AS	ME
Beliefs About Mathematics (BAM)	-.39***	.32***	-.34***	-.28***
Mathematical Self-Concept (MSC)		-.62***	.36***	.18*
Mathematics Anxiety (MA)			-.28**	-.12
Arithmetic Skills (AS)				.32***
Midterm Examination (ME)				

[a] $N = 92$.
*$p < .05$.
**$p < .005$.
***$p < .001$.

Table 3

Correlation of Age and Number of Years Since Last Mathematics Course with Mathematical Self-Concept and Mathematics Anxiety[a]

	No. Yrs.	MSC	MA
Age	.59*	-.48*	.45*
Number of Years Since Last Mathematics Course		-.49*	.37*

[a] $N = 84$.
*$p < .001$.